BROOKINGS GLOBAL ECONOMY AND DEVELOPMENT

BRAZIL AS AN ECONOMIC SUPERPOWER?
UNDERSTANDING BRAZIL'S CHANGING ROLE
IN THE GLOBAL ECONOMY

BRAZIL: THE CHALLENGES IN BECOMING AN AGRICULTURAL SUPERPOWER

DRAFT 1

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ABSTRACT

This paper provides an overview of Brazil's agroindustrial sector and examines the challenges Brazil faces in becoming an agricultural superpower. These challenges include restoring the investment pattern in infrastructure, science and technology, and human capital of previous decades, with the difference that this time the role of private-sector financing will necessarily be much more important. Other challenges include environmental sustainability, sanitary and food quality/security conditions, and trade policy and negotiations. The public sector has yet to deal with centuries-old issues such as rural labor relations, agrarian reform, and Indian issues.

I. INTRODUCTION

The impressive performance of Brazil's agribusiness (agriculture and agroindustry) during the twentieth century resulted from an ambitious national economic development strategy, conceived in the early 1930s, and whose implementation took six or seven decades. This project promoting industrialization and urbanization demanded overcoming food supply and foreign reserve restrictions, with a key role played by agriculture. The project also entailed territorial occupation based on infrastructure expansion, research and technology, and human capital investments (including substantial immigration), plus a set of sectoral policies that were intermittently but consistently carried out throughout several different political regimes and government administrations.

The major test of the success of this strategy took place in the mid-1980s, when government support had to be severely curtailed and the economy was opened to foreign competition. Despite that initiative, the value of agricultural production kept its post–World War II pace, doubling about every 20 years. Nonetheless, today agriculture accounts for only 5% of Brazil's GDP (one-fifth of its 1947 share), meaning that relative agricultural income was shrinking. In the meantime, after the war, an increasingly sophisticated agribusiness sector developed, which currently represents some 30% of Brazil's GDP, with strong participation from multinational companies.

The social returns on investments in agriculture began to be perceptible starting in the mid-1970s, when real food prices began a continuous 30-year fall of almost 80% at the retail level, and of 60% at the farm gate. It is remarkable that the agroindustry and retail margins have also declined at a time of strong market concentration and fierce competition. It took such a deep fall in food prices to make a historical improvement in Brazil's income distribution possible during the 1990s. On the external front, the agribusiness sector provided $10–15 billion in annual trade surpluses that were strategic to securing the country's solvency in the turbulent 1990s. These surpluses helped keep Brazil from being forced into a period of growth slower than the then-present 2.5% annual rate.

How could farmers bear such a reduction in prices and still expand production? The major explanation lies in farming's total factor productivity, which doubled in the 30 years to 2005 and explains around 70% of the growth in farm output. In addition, artificially high labor costs, low interest rates, and growing land supplies all favored mechanization and large-scale farming. That meant that many farmers who could not keep pace with new technology had to abandon agriculture. Huge rural labor migrations and worrying environmental depletion were the main costs of the agribusiness success.

The structure of the paper is as follows. The next section starts with a discussion of the Vargas project of industrialization that started in the 1930s; section III introduces the role of agriculture in the Vargas project; section IV presents data on agribusiness's performance over the last decades; sections V through X discuss the growth challenges faced by the country, in light of economic integration, science and technology, human capital, environmental concerns, and investments; and finally, sections XI and XII present future perspectives for Brazil, taking in to account the world scenario, as well as offering concluding remarks.

II. INDUSTRIALIZATION: THE VARGAS PROJECT

In 1994, president-elect Fernando Henrique Cardoso announced the end of the Getúlio Vargas era in his farewell speech in the Senate. The death of the Vargas project had been announced at least three times before: first in 1945, when the dictator Vargas was overthrown; again in 1954, when Vargas died; and in last in 1964, when a military coup overthrew the constitutionally elected president João Goulart—a Vargas man.[1]

Since the beginning of the twentieth century, Brazil has firmly wished to move from an agrarian to an urban, industrialized society, implementing a national project aimed at that goal. At the time, Brazil—like the rest of the world—was in the midst of the international financial crisis of 1929. Agriculture was the foundation upon which Brazil's economic system

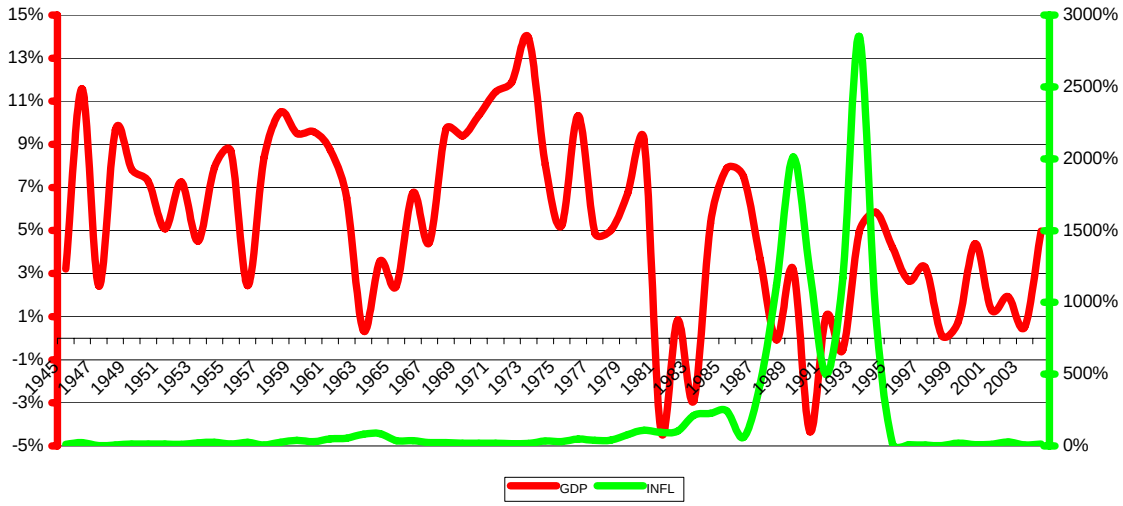
[1] Source: FGV- CPDOC.

functioned up to the beginning of the twentieth century. Seventy percent of its foreign currency revenues came from coffee exports, which dried up when the external funds that helped to support the huge stocks of that commodity evaporated. No wonder a xenophobic mood focusing on import substitution tended to predominate in Brazil's political circles. In fact, a political revolution in 1930, led by Vargas, substituted an ancient agrarian-dominated political system with an industrial-oriented one; the authoritarian Vargas government would last for 15 years, during which many of the modern institutions (e.g., labor unions, social security, public funding for state companies) were created.

Investment capital was raised through public funds (fiscal and inflationary taxation) and foreign investment, which was heavily applied to transportation infrastructure. Human capital was available from European and Asian migration to southern and southeastern Brazil, which began in earnest following the ban on African-based slavery at the end of the nineteenth century. Nascent industry was assured a captive domestic market thanks to a package of protectionist tools, particularly an overvalued currency, import tariffs, and quotas. The strategy was to produce domestically previously imported goods, beginning with consumer goods, and followed by intermediary and capital goods. After Vargas, the strategy was maintained and even intensified by President Juscelino Kubitscheck (who brought the automobile industry to Brazil in 1956). In 1960 the national capital was moved from Rio de Janeiro to Brasilia in the center-west region to (among other reasons) stimulate occupation of frontier areas and the development of agriculture in the savannah lands.

It is clear that during the Vargas period and beyond, Brazil showed outstanding performance, as far as growth is concerned. From 1945 to 1980, the growth rate of its GDP was 7.5% per year, on average. Since then, that rate has fallen to a meager 2.5%. During this time, inflation surged and was only brought under control after half a dozen different economic plans were implemented. As can be seen in Figure 1, in 1994, the Real Plan was able to bring inflation down; however, economic growth remained low. Brazil is still looking for a new project capable of bringing growth back, but only of that special type that keeps inflation down.

Figure 1. Brazil's inflation rate and GDP growth, 1945/2005



Source: FGV and IBGE

III. THE ROLE OF AGRICULTURE

How did agriculture enter the Vargas development project? Agriculture was given a supporting role during Brazil's industrialization. As urbanization accelerated, the poor nutritional status of the population became a strong political issue. Josué de Castro, a medical doctor and geographer, led important studies concerning hunger in Brazil in the 1930s. In 1946 he published the book *Geografia da Fome* (The Geography of Hunger), which blamed hunger on two basic causes: a lack of production and a lack of income (purchasing power). In other words: the forces of supply and demand. Vargas's reaction was twofold. The first, shortsighted but long lasting, focused on market intervention to make food accessible to the poor; a sequence of public institutions was created to control food production and prices, which were restructured in the 1960s and all but extinct in by the 1990s. The second front was to open the "Marcha para o Oeste" (Westward March) designed to occupy the savannah areas of Brazil's frontier lands.

In addition to providing food, agriculture was supposed to continue generating foreign currency to fund the imports demanded by industrialization. Coffee exports, on one hand,

provided much needed foreign currency, but when revenues from coffee exports rose, the exchange rate appreciated, making life harder on the nascent industrial sector. To help the industrialization process, right in the beginning of his mandate (1930), Vargas instituted a multiple exchange rate regime. In practice this was nothing more than a coffee export tax (*confisco*), through which exporters were taxed with an overvalued exchange rate. This heavy reliance on coffee exports served as a reminder that the country was in need of other exportable commodities.

The occupation of the so-called *cerrado* (savannahs) was not a peaceful process; it was unfair and violent, with heavy costs for native populations and migrants from the Northeast. At some point, the occupation process got out of the control of the authorities and as a result one of the stated objectives—establishing a reasonably equitable agrarian system—was not attained. Land ownership concentration also resulted from a combination of technological and production factor prices; cheap land, low subsidized capital, and artificially high labor costs all led to large-scale farming.

Academic discussion tended to oppose, on the one side, the land reform solution—how to deal with the so-called agrarian problem (i.e., land ownership concentration and too many landless)—and, on the other, the farm modernization strategy—to solve the "traditional-agriculture problem," allegedly "efficient but poor." Although most analysts would say that the first option was rejected, the truth is that Brazil has since been involved with an intense and never-ending land reform and colonization program. The fact is that the political options fell upon a mixed strategy. A complex of agricultural modernization policies was put in place in the 1960s encompassing price supports and subsidized credit. Growth in the agrobusiness sector also had environmental costs, such as soil degradation, water misuse and contamination, air pollution, fauna and flora sacrifices, and deforestation. Only recently have concrete steps been taken to address these problems, and only more recently have the very first concrete results become visible.

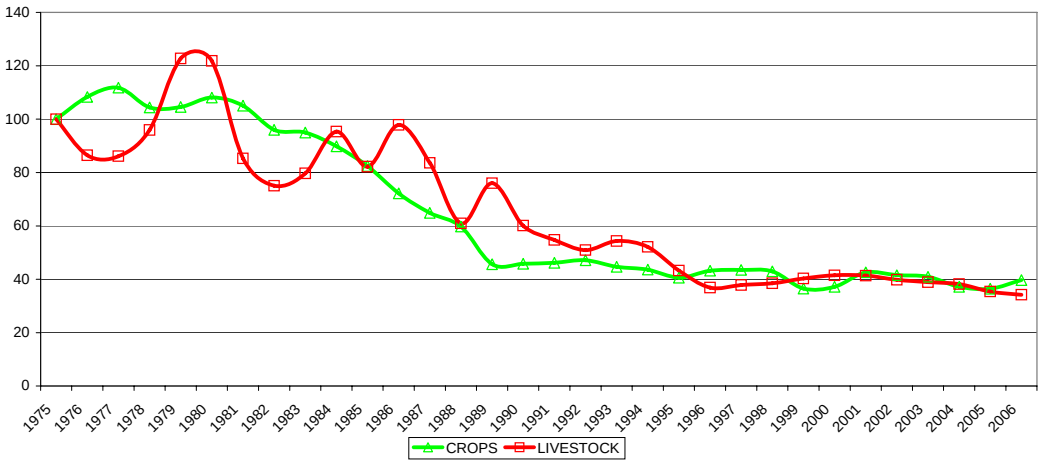
By the mid-1980s, the federal government's financing capacity collapsed, so that even the agricultural credit and commercialization instruments had to be severely curtailed. The private sector took most regional development into its own hands, including the investment

of hundreds of billion dollars in farm capital, warehouses, and processing facilities. Fortunately, new technology was kept flowing in and the agribusiness sector was able to employ it efficiently by exporting part of the increased output, thereby avoiding a weak domestic market that would have inhibited the growth of strong agroenergy, fiber, grain, and meat agribusinesses. Plenty of foreign reserves were generated to help Brazil keep its financial solvency during the severe financial crises of the 1990s.

IV. THE PERFORMANCE OF AGRIBUSINESS

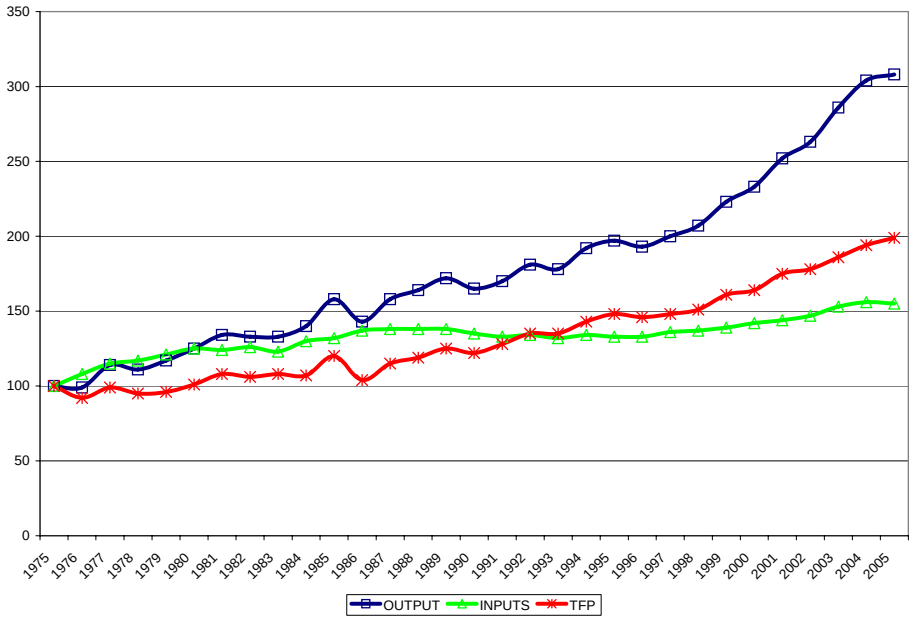
Six decades after the initial official programs, and 20 years after the direct policy (credit, price support, and storage) instruments began to be curtailed, a long-term evaluation of the agribusiness experience is finally possible. Figures 2 and 3 show that farm prices—both for crops and livestock—fell about 60% in real terms from 1975 to 2006, while output more than tripled. These results are measurable by total farm increase in productivity, which doubled over the same time period.

Figure 2. Farm crops and livestock real price indexes



Source: FGV, author's elaboration.

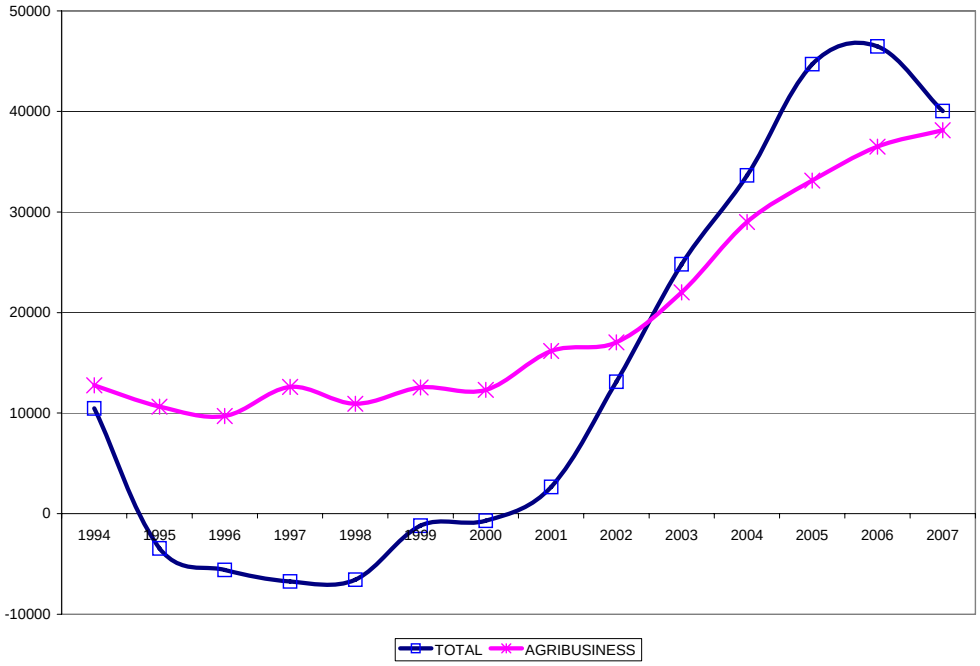
Figure 3. Farm output, inputs, and total factor productivity, 1975/2006



Source: Gasques et al. (2006).

Productivity growth permitted Brazil's agribusiness to expand impressively in international markets. As indicated in Figure 4, the agribusiness sector contributed between US$10 billion and US$15 billion in trade surpluses per year during the 1990s, when the economy as a whole suffered chronic deficits. Thanks to the performance of the agribusiness sector, Brazil avoided insolvency until 1998, when the substantial capital flight demanded deep changes in the exchange rate regime (fluctuation and devaluation).

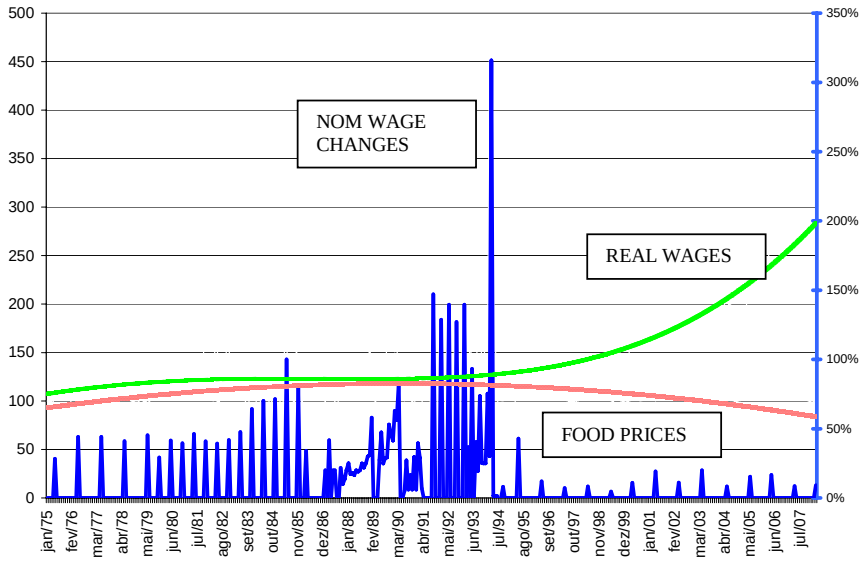
Figure 4. Brazil's total and agribusiness trade surpluses, 1994/2007



Source: MDIC and CEPEA-USP.

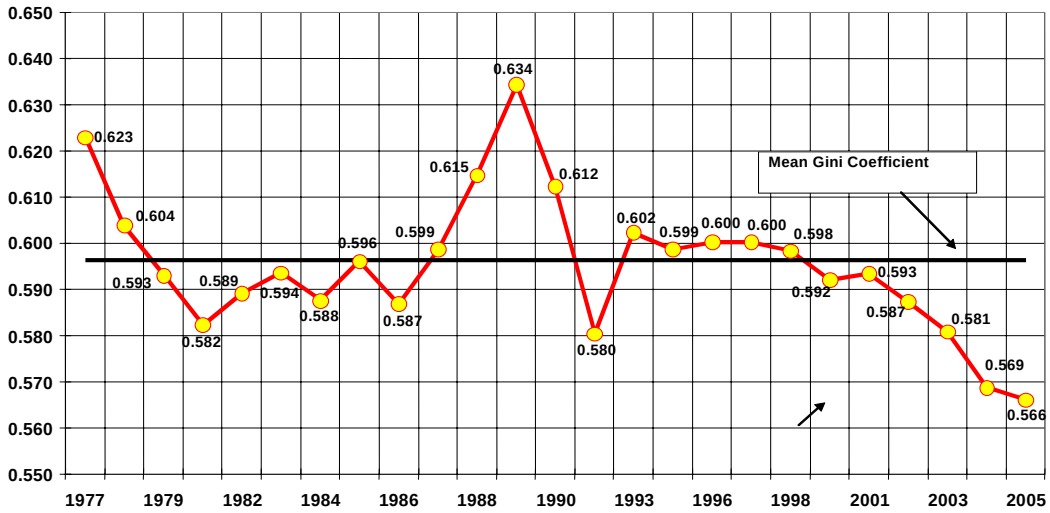
Also thanks to this productivity effect, since the mid-1990s Brazil has been able to reduce income concentration. As can be seen in Figure 5, in the 1990s, minimum wage increases took place at a time of decreasing real food prices, thus leading to higher real wages; poor families were able to spend more, not only on food but on other consumer goods as well. That made possible, for instance, the redistribution of income through several sequential government programs, which culminated with the so-called Bolsa Família (Family Grant), which transferred cash to more than 11 million poor families. Figure 6 shows that the Gini index of income concentration has been decreasing since 2001, so that for the first time such money transfers have turned into real purchasing power increase for poor families. Increased consumption, which began with food, soon extended to other items, such as housing improvements, home stoves, refrigerators, and furniture. Recent data (shown in Figure 7) indicate that the poorest 10% of Brazil's population had an 8% annual growth in per capita income from 2001 to 2005, while average annual growth was 0.9%.

Figure 5. Nominal minimum wage changes, real food costs to consumers, and real minimum wages



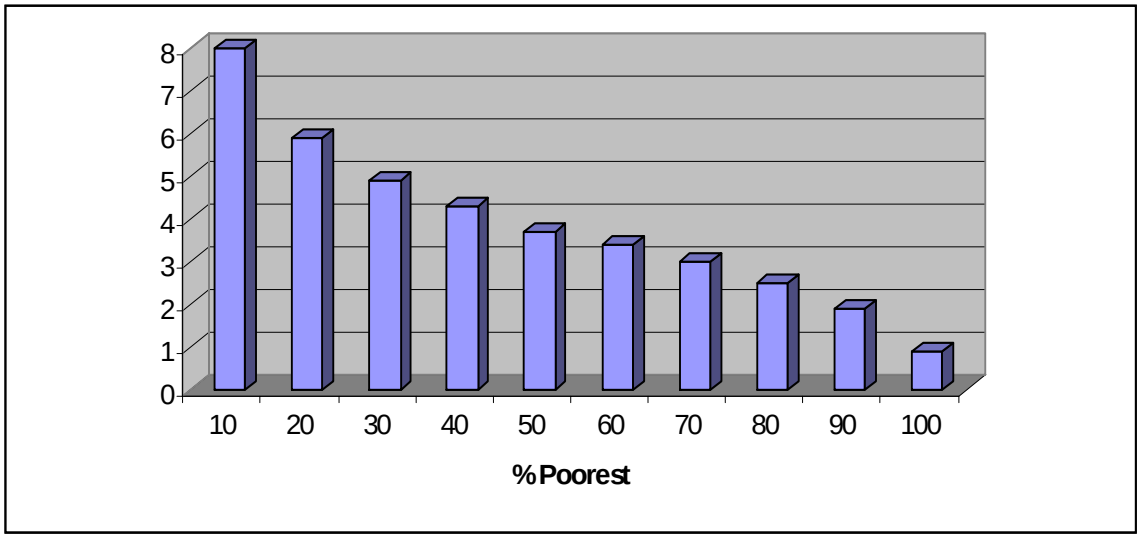
Source: FIPE, http://www.portalbrasil.net/salariominimo.htm, elaboration of the author.

Figure 6. Gini income distribution coefficient, Brazil, 1977/2005



Source: Paes de Barros, R. (2006) "A Recente Queda na Desigualdade no Brasil: magnitude, determinantes e conseqüências". PPT presentation, IPEA, Brasília.

Figure 7. Per capita income growth according to poorest accumulated classes, Brazil, 2001/2005



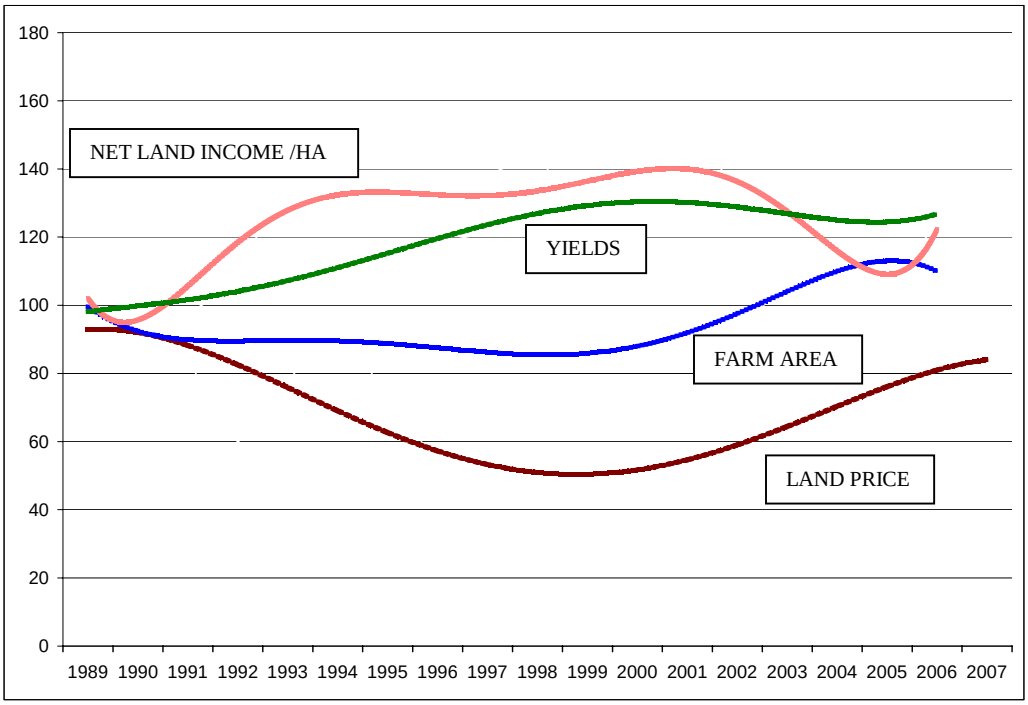
Source: Paes de Barros.

Brazil has relied, since the 1990s, on significant trade surpluses on agricultural products and on income redistribution measures that are no longer simple short-term solutions but are able to offer long-term benefits to the poor. Today Brazil appears to be on the verge of a long cycle of more domestically oriented economic growth; the country can count on a strong and competitive agribusiness sector as one of its leading sectors.

This historical success would not be entirely told if the economic and social conditions of farmers—the main actors of the story—were not examined. Two points deserve to be stressed. The first is the extreme insecurity under which farmers do their businesses. The second is the sacrifices many farmers had to bear during the changing process.

Among the many different ways of analyzing farmers' economic progress, it suffices to examine the evolution of the value of their main asset, land, as can be seen in Figure 8.

Figure 8. Yields versus price, income and use of land, 1989/2007



Source: FGV, IBGE, authors' calculations.

Over the last 17 years, the real price of land at first decreased 50% compared to 1989 and then increased back 70% by 2007. Since land alone stands for 70% or more of a farm's total assets, one concludes that farming is very risky in Brazil. Why did this rapid fluctuation in land value happen? In Figure 8, one sees that the average return per hectare[2] jumped more than 35% in the four years from 1989 to 1993 and fell 40% from 2002 to 2006. That fluctuation is attributable not to prices but to increasing yields and the fall in chemical input prices, stimulating output expansion, which up to 1999 demanded no additional expansion of land. Indeed, as yields increased, the "effective" (yield-corrected) land supply was growing and its price was falling. When yields stopped increasing, more land was needed, but the "effective" supply of land stagnated and prices began to rise again. Farm asset value varies widely and helps explain why farmers have had hard times meeting financial obligations, despite yield gains and growing output.

[2] Land net return is an index dividing terms of trade (the price received by farmers over the price paid, multiplied by yield per hectare).

The second point to complete the farmers' story may seem paradoxical: While large numbers of farmers left the agricultural business, the government insisted on settling more people in the farming sector. Brazil's share of the rural population fell from 64% of the total in 1950 to 44% in 1970 and to 22% in 1996 (the most recent census data available). That has meant that since World War II, every decade has seen about 10 to 15 million people in Brazil leave rural areas and move to urban centers.[3] In 1998, the mean per capita income in rural areas was still only half that in urban areas.[4] Despite this income discrepancy, the official agrarian reform programs have been settling (or promising to settle) around 70,000 to 80,000 families per year over last 10 years.[5] In addition, the land reform program is proceeding without a visible conclusion and under practically continuous conflicts over land ownership, thus deepening the environment of uncertainty in farming activities.

V. BRAZIL'S GROWTH CHALLENGES

Sustainable economic growth has to be a consequence of productivity increases, as pointed out by Helpman and Krugman (1993). Brazil and Latin American countries in general have lagged behind as far as economic development is concerned in the four decades since World War II (Summers and Heston 1991). Labor productivity in those countries has remained at about 30% of labor productivity in the United States during that period. One hypothesis is that closing their economies to trade—a strategy to reach industrialization—was one major factor explaining the observed stagnation in productivity in Latin American countries. Others factors were underinvestments in human capital, science and technology, and infrastructure.

Pires and Garcia (2004) show a decomposition of total factor productivity (TFP) among countries in terms of technical progress, technical efficiency, scale effect, and allocative efficiency. Brazil's TFP was hit by allocative factors but not by a lack of technical progress,

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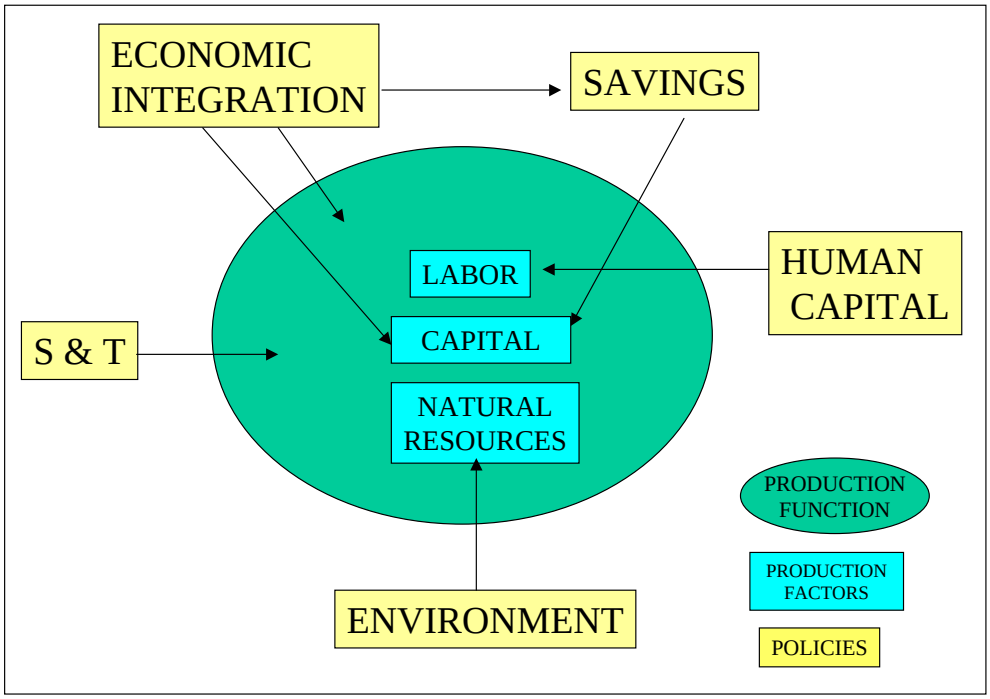
[3] Camarano and Abramovay (1999).
[4] Kassouf (2005).
[5] http://64.233.169.104/search?q=cache:cKSiqXYwogUJ:www.reporterbrasil.org.br/exibe.php%3Fid%3D510+n%C3%BAmero+assentados+FHC+LULA&hl=pt-BR&ct=clnk&cd=4&gl=br

as were other Latin American countries. Allocative efficiency has been directly associated with the degrees of openness and inversely associated with the importance of the public sector in the economy. Brazil has a 40% share of its GDP spent by the government and still is a rather closed economy, with a ratio of imports plus exports to GDP of 21.5%.

As can be seen from Figure 9, growth policies can be targeted at the production function (science and technology and economic integration) and/or the factors of production. For labor, human capital policies can be designed; for capital, economic (capital market) integration and savings policies can be developed; and for natural resources, environment policies can be devised.

Figure 9. Policies for enhancing factor of production and production function



VI. ECONOMIC INTEGRATION

Brazil has partially opened its economy. As imports were taxed, by the mid-1980s, the imports/GDP ratio had fallen to only 6.6% (during which time the mean tariff rate was 45%). In 1996, this mean rate had fallen to 13.6% (while the highest one was still kept at 35%)[6]. Since 2000, and up to 2006, the imports ratio was close to 12%. For Brazilian agribusiness, the remaining barriers to industrial trade and services have been obstacles at the trade negotiation tables.

Brazil has concentrated its trade efforts on Mercosur, within which the performance of each member has been dictated mostly by macroeconomic factors, particularly the cyclical exchange rate and GDP growth. This trade agreement, as should be expected in cases involving similarly endowed countries, has led predominantly to intraindustry trade, although Brazil was favored on manufactured goods and Argentina on agricultural commodities, fuel, and other nontraditional goods thanks to gains of scale. Thanks to growth in productivity, Brazil has been able to expand as a global trader faster than Argentina, and it has also done better in trading within Mercosur.

Although Brazil's trade strategy has been condemned for lacking focus, Harrison et al. (2003) argued that Brazil can benefit from the strategy of simultaneously negotiating trade agreements such as the Free Trade Area of the Americas (FTAA) and the Mercosur–European Union agreement while supporting the Doha liberalization agenda. Since Brazil's tariff structure favors capital-intensive industry, liberalization would strengthen labor-intensive sectors, thus increasing the demand for, and wages of, unskilled labor. Therefore, Brazil could gain if both the United States and the EU offered tariff free access to agricultural markets in exchange for liberalized industrial markets. If the most protected markets of each were not opened, the FTAA would be preferred as a trade partner (because of the other FTAA partners). The FTAA and EU- Mercosur are trade-creating agreements for the countries involved, but multilateral negotiations with only 50% tariff liberalization

[6] Silber (2003).

would bring gains to the world as a whole four times greater than just FTAA or the Mercosur-EU agreements.

Anderson et al. (2006) showed that full liberalization in the Doha Round would lead to a 0.67% gain in the world's real income (US$287 billion/year), 70% of which accruing to high-income countries. Interestingly enough, two-thirds of the gains would be derived just from agricultural liberalization. Half the benefits will come from South-South liberalizations because of the observed recent increase in trade within emerging countries at slightly higher than average tariffs. Ninety-three percent of the gains from liberalization would come from tariff removal versus export and domestic subsidies.

Most analyses of economic integration—static as they are from a technological perspective, and subject to several methodological constraints—point to very small gains for liberalizing countries. Results for the United States prompted Krugman (1995) to conclude that "yet there is a dirty little secret in international trade. The measurable costs of protectionist policies—the reductions in real income that can be attributed to tariffs and import quotas—are not all that large. … For example, most estimates of the cost of protection in the United States put it well under 1 percent of GDP." Similar results were found by Ferreira Filho and Horridge (2006), who showed that Brazil's GDP would rise by 0.31% in a full worldwide liberalization scenario.[7]

Most Latin American countries implemented the import substitution strategy, thus ignoring factors such as the minimum size of plants, increasing returns to scale and indivisibilities in the production process, which explain the observed relationship between exports and economic growth. In addition to these sources of inefficiency, Bacha and Bonelli (2004) estimate that the relative price of investment goods doubled between the 1950s and the 1980s in Brazil—most of which is attributable to an import substitution development strategy that protected the domestic industrial sector. In other words, closing the economy

[7] This study, for instance, uses a computable general equilibrium static interregional model of Brazil based on the ORANIG model of Australia (Horridge 2000) with given technological input/output data for 1996. Other relevant assumptions are that national levels of labor employment and capital are fixed, land is fixed in each sector, and the trade balance is a fixed share of GDP.

brings about underinvestment in capital goods because it makes these goods more expensive.

Increasing returns to scale is a key factor in explaining major puzzles of recent integration experiences, such as the predominance of trade between similar countries (in terms of factor endowments) and the strength of intraindustry trade. Scale economies may arise from the expansion of exports and imports of intermediate goods (or parts). Consumers benefit from cheaper imports of large-scale production, both nationally and abroad.

The role of trade as an important factor affecting the availability and distribution of knowledge is discussed by Grossman and Helpman (1995), who show that trade can distribute knowledge directly and indirectly (through the transference of intermediate goods, which embody research and development, R&D). In their analysis, Targetti and Forti (1997) use the Kaldorian "cumulative causation" and the "technology gap" approaches, which can be used to describe how a country lagging behind the technological frontier can benefit from technology spillover, if it has the potential to do so. Baumol and Wolf (1988) identified some convergence clubs (groups within which convergence takes place) as being industrialized countries, centrally planned economies, and middle-income economies. Convergence was not observed in the low-income-country group.

In the case of agriculture, it has long been shown that trade is a crucial condition for sustainable technical innovation and growth. Cochrane (1953) argued that because of what he called the "technological treadmill," innovation is profitable for the first adopters, but the incentives soon wane. As more and more farmers adopt the new technology, prices decline and profits are reduced because of the inelasticity of domestic demand. Economic integration, however, has the fortunate effect of expanding the market and increasing demand elasticity, thereby taking farmers—at least partially—off the treadmill trap, making it possible for scale economies to be exploited for the benefit of producers and consumers alike. The growing efficiency of modern agriculture in Brazil could be attributed in great part to the international integration the country engaged in during the 1990s.

It is worth mentioning that protectionism, by depressing agricultural prices, leads to the gradual loss of that providential role attributed to external markets. It is as if the security net is gradually moved down, so that farmers will need to reduce costs as protectionism advances. That may be related to continuous increases in farm size—to explore economies of scale—with probable negative social effects, or even to the need to look for new, cheaper lands with probable negative environmental effects.

VII. SCIENCE AND TECHNOLOGY

Brazil has a structured science and technology (S&T) system that is increasingly integrating governmental and private business sectors.[8] However, Brazil still lags behind other emerging countries like China, India, and South Korea, with a total expenditure in S&T representing 4% of GDP. Some aspects of evidence for Brazil's performance in S&T are that (1) scientific production is increasing around 8% a year; and (2) doctor graduation rates are increasing 14% a year, with a current flow pf around 7,500 doctors/year (the number of researchers graduating annually, 126,000, is still very low, at less than 0.5 per 1,000 people). The major challenge is to expand S&T production and capacity building while at the same time accelerating the transfer of technology to the business sector. Private and foreign companies have a small but increasing contribution; American companies spend 0.4% of sales revenue on R&D in Brazil, which ranks fifth in terms of countries receiving American R&D money over the next three years—behind China, the United States, India, the United Kingdom, and Germany—according to the Economist Intelligence Unit.

Investments in agricultural technology have not been disregarded. In the early 1970s, EMBRAPA—the Brazilian Agricultural Research Company—was created by the military regime as the core agricultural institution and the coordinator of a structured agricultural research system. Funding of the system has not been maintained at desirable trends, but minimum levels have been assured so that the flow and standard of research have been

[8] Presentation by E.M. Krieger at IEA-USP: www.iea.usp.br/iea/online/midiateca/perspectivasctbrkrieger.ppt.

preserved by different administrations since the system was implemented. Recent figures indicate that EMBRAPA's yearly budget is close to US$300 million, or 0.6% of agricultural GDP. It is important to emphasize that EMBRAPA is the leading public institution generating technology for the agricultural sector; however, most universities also conduct research and develop agricultural technology. For instance, the University of São Paulo's share of overall scientific publication is 24% of Brazil's total.

One major challenge faced by the agricultural research system was to make the occupation of the *cerrado* viable, particularly with the adaptation of soybeans, but also with beef, pork, poultry, milk, and vegetables.[9] Among the notable techniques produced/adapted by EMBRAPA was the no-till system, which simplified operations and reduced the costs associated with the diversification, rotation, and succession of (multiple) crops. Additionally, EMBRAPA devised cattle-crop association and its optimistic perspectives regarding the *cerrado*'s sustainability. *Cerrado* soils have favorable physical conditions but are highly acid and low in phosphorus, calcium, magnesium, and potassium. New techniques were also developed to detect and correct the acidity and fertility problems adapted to different production systems. Agricultural gypsum—a by-product phosphatic fertilizers—is used to correct calcium deficiencies in the deepest soil layers, reducing aluminum saturation and providing for the soil's sulfur needs.

Maize (corn), soybeans, and coffee are the crops that benefited the most from the use of gypsum. Soybeans, beans, and peas, meanwhile, have expressly benefited from the nitrogen-fixing bacteria inoculation practice. Besides saving large amounts of urea, inoculation also provides environmental gains since it avoids water source contamination.

EMBRAPA's current priorities encompass:[10]

a) Precision in agriculture;
b) Environment services in agriculture;

[9] See www.cpac.embrapa.be/tecnologias for information on EMBRAPA's contribution to *cerrado* agriculture.
[10] Lima (2007).

c) Health-promoting (functional) foods;
d) Aquaculture technologies;
e) Biosafety for genetically modified crops;
f) High-quality beef;
g) Organic agriculture;
h) Conservation of national genetic resources;
i) Tools for plant sanitary protection;
j) Forest for energy production;
k) Environmental, social, and economic effects of the beef industry;
l) Nanotechnology;
m) Sustainable production of sugarcane for energy purposes;
n) Genomics technologies for the development of water-use-efficient plants;
o) Technologies for biodiesel production;
p) Genomics for the advancement of animal breeding and production;
q) Climatic risks zoning for small farming agriculture, bioenergy, and pastures.

VIII. HUMAN CAPITAL

Brazil has some positive educational results to show over the last 30 years, but there remains a long way to go. For instance, illiteracy (within those age 15 or older) has been reduced from 33.6% of the population in 1970 to 11.1% in 2007, which is still a large rate and only lower than Bolivia's in Latin America. In addition, 26% of the Brazilian population 15 years and older is functionally illiterate, defined as having fewer than 4 years of schooling.

The rural population over 15 years old has a mean 3.4 years of schooling, while the urban mean is 7.0 years, so farm activity is mostly hit by the lack of formal education. The rural sector has an illiteracy rate of 30% for people over 15 years of age. This is in part due to the short supply of schooling opportunities in rural areas; only 9.4% of the rural young age 15–17 have a school available to them. On the other hand, most of the progress in basic schooling took place within the poor part of the population; from 1992 to 2001, enrollment in primary education increased form 97% to 99% in the 20% richest bracket of the

population and from 75% to 94% in the 20% poorest bracket.[11] Since illiteracy ranges from 2.7% for the population age 15 to 19 years to 30% for those between 65 and 69 years, the dynamics of the population indicate a strong trend towards reducing the problem over time.

Brazil has a long way to go to improve the educational level of the majority of its population not only for competitive edge but also as the essential way to seriously and permanently fight poverty. Quantitative results at the elementary level from efforts of the 1990s and 2000s are good; however, overall student proficiency is very low. Human capital investments take a long time to mature, so the sooner they begin, the better for the country.

IX. THE ENVIRONMENT

Environmental problems must be examined within a social and economic cost/benefit analysis, provided that costs are duly internalized to firms. For instance, it is usual to observe that expanding agriculture anchored on Green Revolution practices and stimulated by fiscal incentives and cheap credit provoke a series of negative environmental effects. But most of these effects are reported to have no grounding in hard evidence. It is an unproven matter that deforestation is caused by crop or beef cattle activities. There is, on the other hand, evidence that both may be carried out in economically sound ways.[12] Beef cattle ranching has been shown to be a profitable activity, apart from deforestation revenues. On the other hand, it is true that beef cattle are associated with the emission of the methane tariff, as it corresponds to 60% of carbon dioxide emissions from the farm sector.[13]

Technology alone does not help much. About 17% of the open area in the *cerrado*, for instance, is currently abandoned; land (a major asset for many farmers) is used up to exhaustion, which does not take a long time, despite the availability of technology to circumvent degradation through no-tillage systems and pasture-crop integration/rotation.

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[11] http://siteresources.worldbank.org/EDUCATION/Resources/Education-Notes/EdNotesBrazil.pdf.
[12] Margulis (2003).
[13] Ministério de Ciência e Tecnologia (2004).

Going after new land is still privately cheaper than preserving the older, more degraded land currently in use.

Among the environmental risks, one can mention illegal deforestation, intentional and unintentional burning, river sedimentary deposits, provoking water scarcity and a reduction of water quality, and air pollution (nitrogen oxide, carbon monoxide, hydrocarbons, and particulate matter, in addition to other highly toxic substances). Again, there is not enough hard evidence on the extent and effects of these events.

As has been the case of food security (and quality), the world market—and ultimately consumers in general—will learn to play a fundamental role in the interaction between production of food and the natural resources required for that production. This will come either through price incentives—i.e., punishment by tariff and/or nontariff barriers—or by changes in the production process introduced to ensure the safety of food and more environmentally friendly production practices. Then, technology will be able to play a key role in enhancing production efficiency, the intensification of land use, and improving grass and feed quality.

Environmentally recommended practices, when privately profitable, have been adopted at fast rates by farmers. Soybean and corn in successive (multiple) croppings have permitted the use of the same land tract twice. That is a highly intensive use of land with possible harmful environment consequences, but high-intensity land use is also a substitute for deforestation. On the positive side, the accelerated expansion of the no-tillage system is a strong example of an environmentally friendly practice.

X. SAVINGS AND INVESTMENT

The Brazilian farm sector has shown enough capacity to grow expansively over the past thirty years, while prices decreased thanks to substantial productivity growth. A significant

part of the investment necessary to achieve this was facilitated by cheap government credit from the 1960s to the 1980s.[14] Cheap credit also played the role of partially offsetting policy discrimination against agriculture through, for instance, overvalued currency and price controls.[15]

During the sequence of inflation-fighting economic reforms in the 1980s—marked by deep market intervention and price controls—credit supply was curtailed, and the outstanding debt was adjusted at monetary correction rates. These rates were considered too high by many farmers, who since that time had been involved in cyclically renegotiating repayments. Additionally, as the flow of official credit was curtailed and/or access to it was denied because of overdue debt, farmers adopted the only strategy left: investing when savings and/or suppliers' credit were available, i.e., during periods of high profitability. This creates a cyclical pattern that leads to the majority of farmers investing simultaneously when the prices of capital goods and inputs are high. As a result, during years of low profitability, farmers are unable to fully repay their debts. This then leads to a new wave of renegotiations. Usually, as a palliative measure, the government agrees to facilitate current repayments related to both official and suppliers' debt. Of course, within a couple of years the problem will show up again. The current 2008 agricultural debt is estimated to be US$74.5 billion, a value very close to agriculture's GDP.[16]

The agricultural debt ended up being transferred to the National Treasury as part of the program that restructured the banking system in the 1990s, known as PROER. So the definitive solution to the problem will come if and when the government takes time to formulate a long-term repayment scheme compatible with the real cash or savings flow from farming. The next step will then be to reestablish normal loans to farmers and, more important, to promote the creation of a savings and loans system, by and for farmers, to avoid the present vicious cyclical investment pattern.

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[14] Rahal estimates that the highest rural credit subsidy was reached in 1979–80 and that since 1991 its average has been near zero (Rahal 2003).
[15] Barros (1992).
[16] For Brazilian agribusiness GDP estimates, see http://www.cepea.esalq.usp.br/pib/.

As farmers reenter the financial market, it is essential to make sure that the nonfarm investments needed for agribusiness's expected growth are forthcoming. On the one hand, there are those general, nonspecific infrastructure investments like energy and transportation facilities, which are general preconditions for private investment. On the other hand, there are those agribusiness specific investments, like farm and nonfarm processing and storage facilities. Barros et al. (2007)[17] estimate that capital/output ratio in the Brazil's agribusiness sector is close to 2.6, a number very close to the national (whole economy) average. The agribusiness sector has been investing around 17.5% of its GDP. In general, land stands for half the supply chain's capital. Considering a constant capital/output ratio, if agribusiness output grows at 3.6% per year to meet 3.1% yearly growth in domestic demand and 13% growth in exports, capital stock will have to expand 42% in the coming 10 years. The amount of new capital is US$80 billion (17.5% of agribusiness GDP) on average per year for the next ten years.

Farmers will be responsible for 9% (US$7.2 billion) of the overall amount—excluding land—of farm investment per year. Official rural credit,[18] which has been financing just half that amount, has to be expanded proportionally (that is, doubled). That points to the importance of solving the agricultural debt problem to open the possibility of farm investment intensification.

The two major challenges to agribusiness expansion are related to capital restriction. First, there is the issue of available land, which is widely estimated to be around 90 million hectares, not counting current native forest.[19] Second, there is the additional capital needed to put that land to work, which this naive estimate ignores. Many analysts are optimistic about the potential for alternative ways of increasing production based on the lowest possible land-use expansion, by increasing the adoption of multiple croppings in the same land tract, together with crop-cattle-forest cycles in degraded pasturelands.

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[17] See also Feu (2001) and Silva Filho (2001).

[18] Most of the credit for farm investment proceeds from nonmonetary sources, mainly from the Worker Support Fund (FAT). Working capital credit, on the other hand, is funded by demand deposits. See Rezende and Kreter 2007.

[19] http://www.bndes.gov.br/conhecimento/seminario/EduardoSampaio.pdf.

Among the major obstacles facing the expanding agribusiness sector in Brazil, it is important to remember the amount of available capital investment and the lack of previous infrastructure investments in transportation and energy, which also inhibit private investments in agribusiness-related capital. In this later aspect, there have been efforts to set up a regulatory system to attract private partners to invest in infrastructure. There is currently an investment plan (PAC) to be executed with US$35 billion in public and private capital from 2007 to 2010, which includes reforming and building new roads (45,000 km), railways (2,300 km), water transportation systems (67 ports, 1 canal lock) and airports (20). The efficacy of the plan's implementation is still under question, due to the generally observed bureaucratic inefficiency of the public sector, as well as the fact that many of the investments may have a relevant environment impact, thus demanding substantial time for any potential adjustments to be made before the environmental agencies approve the work.

Still another investment-inhibiting factor is the lack of economic security related to institutional uncertainty, which affects land ownership. For example, several farms and technology companies have been subject to unaccountable property-invasion events, most of which have gone unpunished. Despite the growing number of people settled in rural areas, the completion of the land reform process is still beyond the horizon.

XI. WORLD SCENARIO

The new century brought a worrying scenario with respect to the performance of Brazil's agribusiness sector. Brazil will play an important role as the world finds its way out of a dangerous crisis, in which the prices of agricultural commodities and production inputs have exhibited an unprecedented upward trend. The World Bank predicts that to meet growth in demand, cereal supply would have to increase by 50% and that of meat by 85% from 2000 to 2030. The problem emerges if these changes occur too rapidly. According to the IMF,[20] commodity dollar prices for food increased by 57.3% and those for beverages by 47.6% from 2005 to March 2008. Starting in 2002, the rise was 65.5% and 58.5%, respectively,

[20] http://www.imf.org/external/np/res/commod/table1b.pdf.

during the period in which the Food and Agriculture Policy Research Institute estimates that fertilizer prices more than doubled.[21] This evidence suggests that both output and input prices have moved markedly upward, leading to the conclusion that output may increase in response to an expansion of demand and to the rise in commodity prices, but so too will costs.

The price surge is the result of a worldwide expressive growth in emerging and developing countries where food—cereals and meat—demand income elasticity higher than the world average. At the same time, there is an expectation that world agribusiness will help produce energy from new, cleaner sources like ethanol and biodiesel. The fast-growing demand in the natural resources sector—for things such as food, fibers, clean energy, oil, and minerals—means that at least in the short and medium terms such commodities will see their relative prices rise when compared to industrial goods and services.

Unfortunately, an offsetting new wave of productivity increases is not in sight. In the United States, for example, agricultural multifactor productivity, which grew at a rate of 2.01% a year from 1950 to 1989, has been increasing at half that rate since 1990.[22] In Brazil, the last couple of years have seen yields practically stagnate. Nevertheless, the productivity gap between developed and African countries is widening rather than closing.[23] At this time, therefore, it is hard to see that prices will end up declining in response to increasing output.

At the current rate of world economic growth—particularly in China, African oil-producing countries, and other emerging economies—it is expected that demand for agribusiness commodities, such as grains, meat, fibers and energy, will continue to grow firmly, and prices of both output and inputs will remain higher than their 2005–6 level. Agribusiness price increases, coupled with high and increasing oil prices, indicate that accelerated economic growth will continue in tandem with inflation. If inflation is to be restrained, economic growth must be sacrificed. Ironically, the need to grow at a slower rate comes when a leading developed country looks for measures to avoid a recession, and when emerging countries

[21] http://www.fapri.missouri.edu/outreach/publications/2008/FAPRI_MU_Report_03_08.pdf.
[22] http://www.farmfoundation.org/projects/documents/2007PardeyAlstonHandout.pdf.
[23] World Bank. (2007).

appear to have, at least in part, decoupled themselves from the United States. It is probable at this point to say that while economic independence is not very useful, a reduction in growth is inevitable.

If the demand for agribusiness output is not contained, the world risks not only high inflation but also a renewed attack on natural resources. Brazil in particular already faces the challenge of finding ways to effectively preserve its natural resources, especially its rainforest, but also its soil and water supply. A surge in agribusiness production in response to skyrocketing prices and costs will not help to circumvent these difficulties.

XII. CONCLUSION

What challenges does Brazil face in becoming an agricultural superpower? First, it is necessary to restore the investment pattern in infrastructure, science and technology, and human capital of previous decades—with the difference that this time the role of the private sector will necessarily be much more important, financially speaking. The role of the public sector will be very important as well because, to begin with, the private sector depends on proper regulation and institutions developed by the public sector. Fortunately, the federal government has recently launched several infrastructure projects to be developed by the private sector, and important progress has been made regarding the use of biotechnology in agriculture. However, many farmers still feel insecure with respect to land-related ownership conflicts involving so-called social movements. In addition, the public sector is supposed to efficiently deal with new twenty-first-century issues such as environmental matters (i.e., air and water pollution, deforestation), sanitary and food quality/security conditions, and trade negotiations related to various types of protectionism. Meanwhile, the public sector has yet to deal with centuries-old issues such as rural labor relations, agrarian reform, and indigenous peoples' issues.

Within 10 years, Brazil's agribusiness is expected to reach a share of 50% of world coarse grain production, one-third of soybean production, and one-fourth of sugar production; 50% of the exports of broilers and beef will come from Brazil. At the same time Brazil will double its ethanol production. Besides the investments in basic infrastructure

(transportation, energy, etc.), substantial direct agribusiness (farm and agroindustry) investment will be needed, much of which is expected to come from the nonpublic sector, as well as from abroad.

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